

Sedimentary Record Conclusions

1. Shelf-wide in 1989, the dominant grains in upper Keys sands were *Halimeda* or molluscan with generally <10% coral. In the middle and lower Keys, *Halimeda* was dominant on the inner shelf, and coral was dominant on the outer shelf.
2. A 37-year (1952-1989) increase in coralgal (coralline algae) and mollusc grains correlates with the nutrient-effect model that predicts consequences of increased nutrification on reef builders and benthic organisms. Relative increases in these grain types is commensurate with a decrease in coral-framework production. Intensifying coral bioerosion, in particular, is consistent with decreasing coral-substrate availability and a growing, observed, state of reef decline (coral mortality).
3. A 26-year (1963-1989) decrease in upper Keys coral percentages may reflect a lack of the herbivorous black spiny sea urchin *Diadema antillarum*, a shift in competitive balance between coral and algae to favor algae, and a commensurate decrease in space for larval coral recruitment. Implications are that these events are not restricted to the upper Keys but are occurring keys-wide. All are equated with an ecosystem shift from reef-framework-building corals to hardbottom communities.
4. Coral-grain percentages are related to geomorphology, hence, to reef health. A conceptual model shows that coral-grain percentages increase with exposure to nutrient-enriched waters, whether warm or cold. In general, percentages are highest off tidal passes where reef health is poorer, and lowest off islands where vitality is enhanced, indicating that for coral reefs a critical equilibrium exists between physical and biological processes and landforms in the Florida Keys.
5. The sedimentary signature is a reliable proxy indicator of ecosystem vitality in the Florida Keys, resulting in a proposed objective petrographic measure to quantify reef vitality. Implications are that reef sands elsewhere are probably also a proxy record of reef health.
6. Increasing bioerosional, algal, and molluscan sand-grain components are consistent with decreasing production of symbiont-bearing species. This correlation is new evidence for reef decline, and for its extended duration in light of the 25-year absence of *Diadema antillarum* (Lessios et al., 1984).
7. Proposed method to quantify reef vitality through sedimentary petrology: where corals are present yet coral grains form <10% of sediment components, reefs are healthiest. Where coral grains comprise 10% to 29% of the sediment, reefs are declining. Where coral grains constitute >30% of the sand, reef framework is rapidly deteriorating.

Figure 66.